Physics 3204 Unit 1: Motion Review Sheet

Vectors

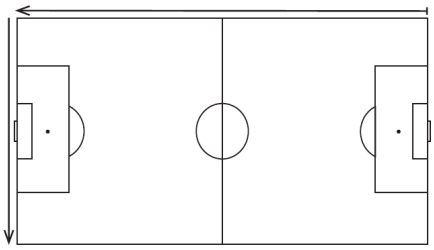
1. Sketch the following vectors
    a. 8.5 m/s [35° W of N]
    b. 12 m/s [58° S of E]

2. Calculate the resultant displacement of a hiker who travels 8.0 km [E] and then 4.0 km [S]. Include a vector diagram.

3. Discuss why [60° S of W] and [30° W of S] may be used to represent the same vector.

4. A cat travels 9.5 km [S], 2.0 km [N], and 5.0 km [W]. Draw a labelled vector diagram and determine the resultant displacement of the cat.

5. A soccer player runs the sidelines of a soccer pitch of dimensions 100.0 m by 65.0 m. What is the distance travelled and resultant displacement of the player?



Relative Motion

6. What is the resultant velocity of an airplane that travels through the air at 152 km/h [E] if there is a 40.0 km/h [S] crosswind? Include a vector diagram. What direction should the plane head if the pilot wants to end up directly East of the starting point?

7. A ship has a velocity of 12.0 km/h [W] with respect to the water. The current flows at 4.0 km/h [N]. Calculate the resultant velocity of the ship. Include a vector diagram.

8. The captain of a boat attempts to travel due East across a river that is 45.0 m wide. If the boat can travel at 5.0 m/s with respect to the water and the current flows at 3.0 m/s [S], how long does it take to travel directly across the river?

9. A cruise ship is travelling North. A passenger on the deck of the ship walks directly west with respect to the ship. Sketch a diagram of the velocity of the passenger with respect to the water.

10. Mark rode his personal watercraft at a constant speed of 25 km/h [N] across a river with a current of 12 km/h [E]. What is Mark's velocity relative to the bank?

11. A small plane flies with a speed of 225 km/h relative to the air. The plane experiences a crosswind blowing 55 km/h [E].
    a. What heading must the pilot use to fly due North?
    b. What is the speed of the plane relative to the ground?
    c. How long would it take the plane to reach an airport 575 km [N] of its starting point?

Projectile Motion

12. A toy car rolls off a lab bench (h = 1.2 m) at 3.0 m/s. How far would it travel horizontally before hitting the ground?

13. A soccer ball is kicked with a speed of 21.0 m/s at an angle of 37.0° above the horizontal. Calculate the time of flight and the maximum height.

14. A projectile is thrown from the top of a 30.0 m building. The initial projectile speed is 12.0 m/s and it is thrown upwards at an angle of 20.0° above the horizontal. Determine the projectile's range.

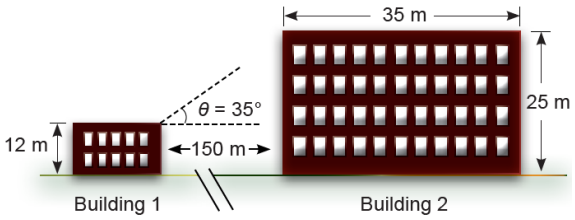
15. A cannon sitting on a 520 m high cliff, fires a cannon ball at 110 m/s, 65° below the horizontal. Calculate the impact velocity of the cannon ball.

16. A projectile is launched from the roof of a school (h = 9.5 m) and hits the ground 2.4 s later, after travelling 28 m horizontally. What was the initial velocity of the projectile? ()

17. Juliet throws a letter to Romeo who is on a balcony 3.0 m above the ground. If she throws it with a velocity of 6.4 m/s [45° above the horizontal] can the letter reach him?

18. A fish at the surface of a pond shoots a stream of water at a bug 0.26 m above the water with a range of 3.0 m. If the initial velocity of the water is 6.0 m/s at 30.0° above the horizontal, does the water hit the bug?

19. A projectile launcher launches a snowball at a velocity of 45 m/s [35° above the horizontal] from the top of building 1. Does the snowball land on top of building 2? Support your answer with calculations.



20. A biker hits a jump on his motorbike at 27.0 m/s 35° above the horizontal. The jump is 120.0 m above the ground. The biker lands on a platform of unknown height 145.0 m away from the cliff. How high is the platform that the biker lands on?

21. Three projectiles are launched at different angles, 25°, 43°, and 75° respectively, but with the same initial speed. All the projectiles are launched from and land on the ground. A

student argues that the projectile launched at 43° will have the longest flight time because it has the largest range. Is the student correct? Explain.

Momentum and Collisions

22. A 2.0×10^3 kg car travelling at 20.0 m/s [N] is struck at an intersection by a 2500 kg pickup truck travelling at 14.0 m/s [W]. If the vehicles stick together upon impact, what will be the velocity of the car-truck combination immediately after the collision?

23. A 0.400 kg grenade is stationary when it explodes into three fragments. One 0.237 kg fragment (A) goes off at 19.7 m/s [35° S of E]. A second fragment (B), of mass 0.066 kg, travels due North, while a third fragment (C), of mass 0.097 kg travels due West. Determine the velocity of the second and third fragments after the explosion.

24. An 86.4 kg defenseman skating at 2.46 m/s [S] collides with an 84 kg centreman skating directly West. The players fall in a tangle and slide at 1.57 m/s [52° S of W]. What was the initial velocity of the centreman?

25. Two identical curling stones (m = 19.5 kg) collide. Stone A is initially at rest and travels 3.2 m/s [30.0° W of N] after the collision. Stone B was travelling 5.0 m/s [N] before the collision. What is the velocity of stone B after the collision?

26. Two billiard balls with identical mass collide (m = 0.160 kg). Prior to the collision, ball A was travelling 2.20 m/s [S] and ball B was travelling 3.10 m/s [W]. After the collision, ball A was travelling 2.56 m/s [14.0° N of W]. Determine the velocity of ball B after the collision.

27. A 1200.0 kg car (A) strikes a stationary 1350.0 kg car (B) off centre from behind. Accident analysis showed that after the collision, car B moved at 8.30 m/s [35° N of E], and car A moved 12.8 m/s [53° N of W]. What was the velocity of the car just before the collision?

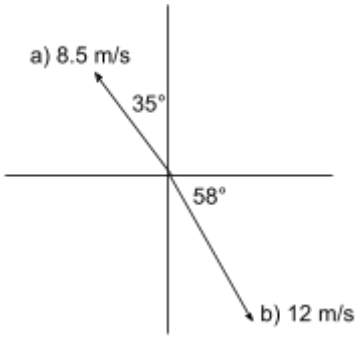
28. Two bumper cars collide and stick together. Car 1 (m = 150 kg) is travelling 3.5 m/s [N] when it strikes car 2 (m = 95 kg), travelling 2.5 m/s [E]. What is their combined velocity after colliding?

29. A 0.058 kg firecracker that is at rest explodes into three fragments. A 0.018 kg fragment moves at 2.40 m/s [N] while a 0.021 kg fragment moves at 1.60 m/s [E]. What will be the velocity of the third fragment?

30. The police are investigating an accident. They have determined that the mass of car A is 2275 kg and was traveling North before the collision, while car B has a mass of 1525 kg and was traveling East just before the collision. Accident analysis has determined that

the cars, when they were locked together, had a velocity of 31 km/h [43° N of E]. If the speed limit was 35 km/h on both streets, should one or both cars be ticketed for speeding?

Answers

1	
2	d = 8.9 km [27° S of E]
3	The directions are the same, the angles are just measured from different places.
4	d = 9.0 km [56° S of W]
5	distance = 165.0 m displacement = 119 m [33° S of W]
6	v = 157 km/h [15° S of E]; 15° N of E
7	v = 12.6 km/h [18° N of W]
8	v = 4.0 m/s [E]; t = 11 s
9	
10	v = 28 km/h [64° N of E]
11a	14° [W of N] or 76° [N of W]
11b	v = 218 km/h
11c	t = 2.64 h
12	t = 0.49 s; d_x = 1.5 m/s
13	t = 2.58 s; $d_{y\text{-}max}$ = 8.14 m
14	t = 2.93 s or -2.09 s; d_x = 33.0 m
15	v_{y2} = 140 m/s; v = 150 m/s [72° below horizontal]
16	v_x = 12 m/s; v_{y1} = 7.8 m/s; v_1 = 14 m/s [34° above horizontal]
17	no; $d_{y\text{-}max}$ = 1.0 m
18	no, it misses; t = 0.58 s (to travel 3.0 m horizontally); d_y = 0.1 m
19	yes; d_x must be between 150 m and 185 m; t = 0.56 s [going up] or t = 4.7 s [coming down]; d_x = 21 m [going up] or d_x = 170 m [coming down]
20	d_y = -109 m; h = 11 m [above ground]
21	no; t is not the only factor involved when calculating range.
22	v = 12 m/s [49° N of W]
23	v_{F2} = 41 m/s [N]; v_{F3} = 39 m/s [W]
24	v_c = 4.1 m/s
25	v_{B2} = 2.7 m/s [54° N of E]
26	v_{B2} = 2.89 m/s [78° S of W]
27	v_{A1} = 15.6 m/s [N]
28	v_2 = 2.35 m/s [66° N of E]
29	v = 0.94 m/s [38o S of W]
30	v_{A1} = 35 km/h [N]; v_{B1} = 56 km/h [E]